Stock intermixing and movement of Atlantic herring (*Clupea harengus*) in the Gulf of Maine and Southern New England

Results from the 2003-2004 tagging project
with preliminary data from 2005

PROJECT BACKGROUND

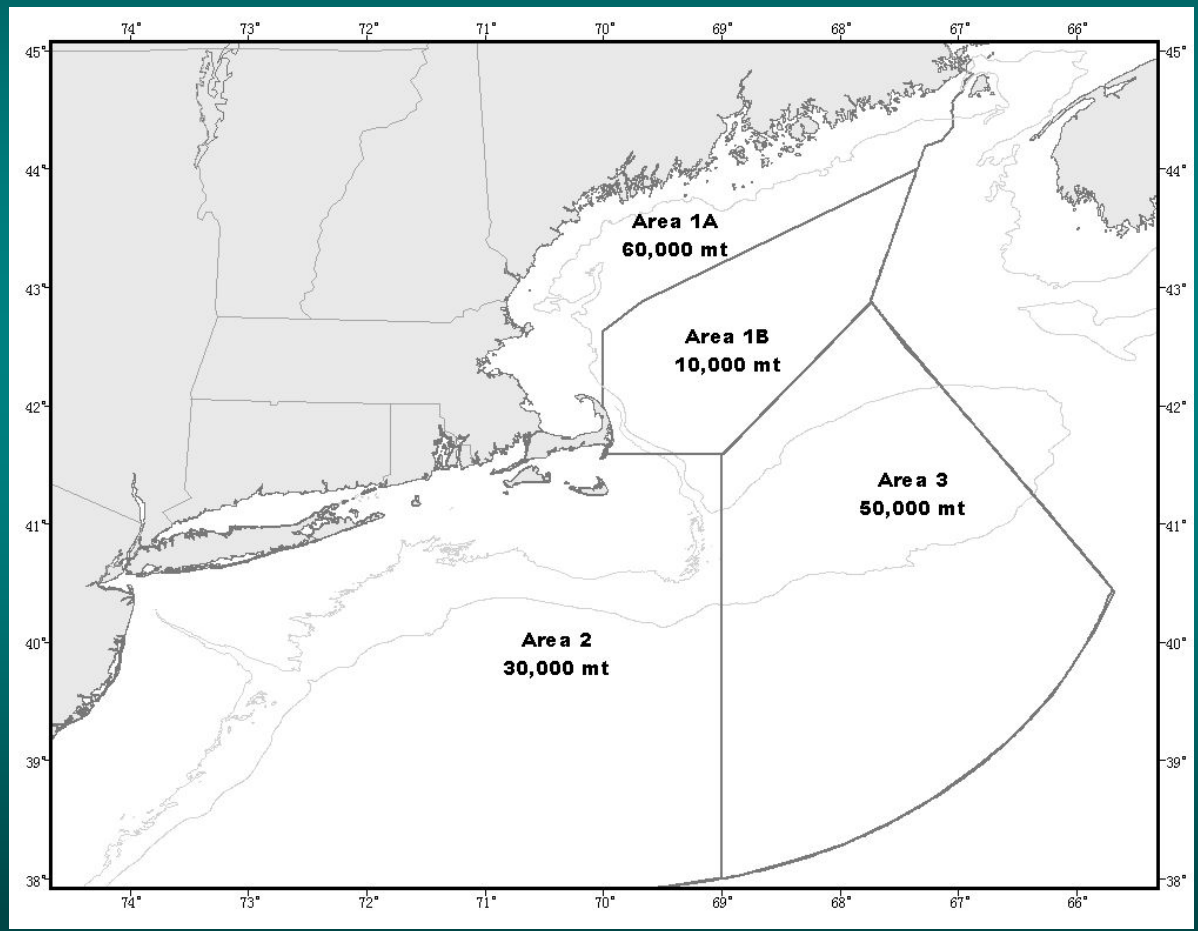
- Atlantic herring range from Labrador to NC in the western Atlantic
- They have been exploited in N. America since pre-colonial times

Fishing weirs in coastal waters

- **Biomass estimated at 2.4 million mt in the study area (US waters and NAFO area 4X)**
- **Currently it is the second largest fishery on the east coast of the US with landings around 100,000 mt**

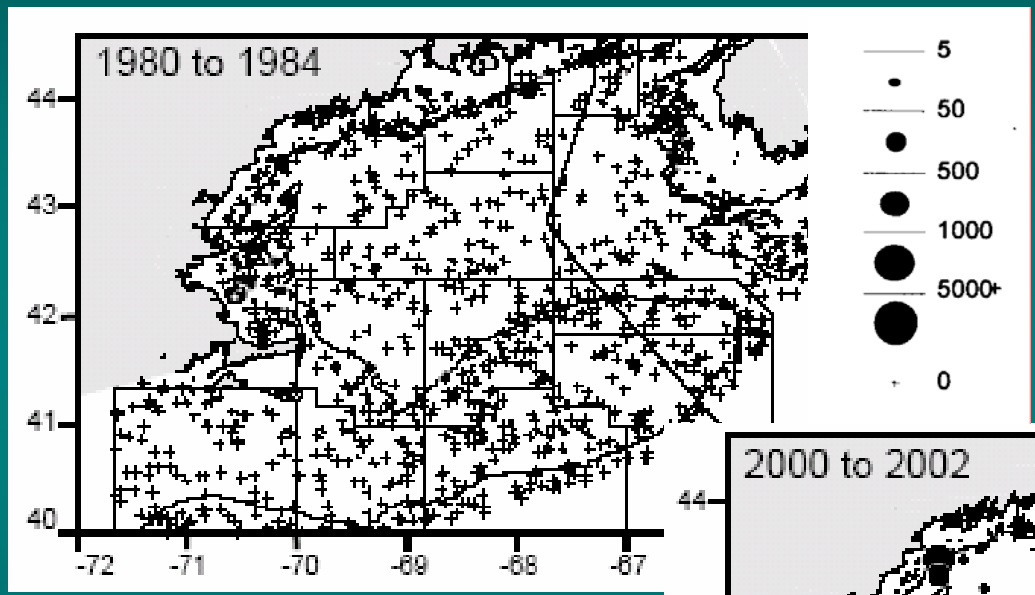
- Herring are also ecologically important, primarily as a forage species for marine mammals, birds and other fish

- **The US fishery is managed by the NEFMC and the ASMFC with area TACs (from 2005)**

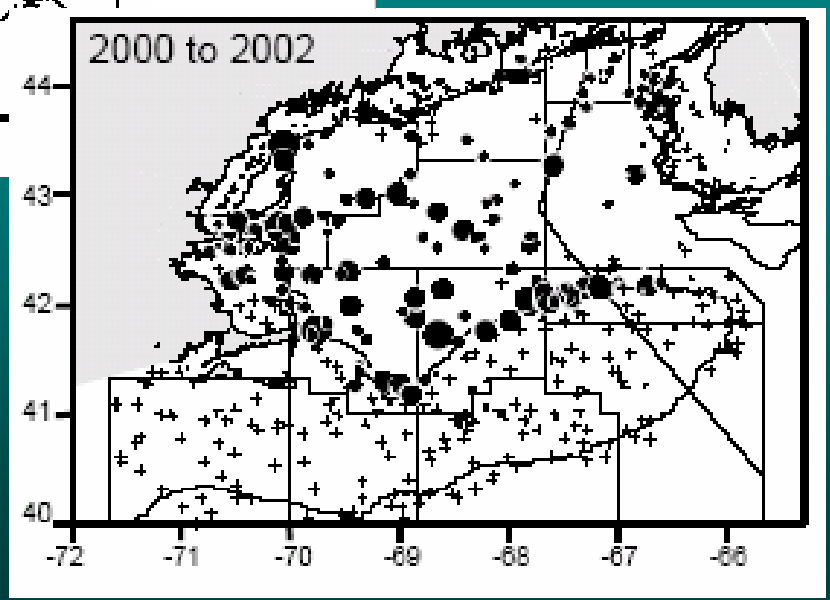


- Management is based on an assumed understanding of stock structure, intermixing and movement within and among areas
- Tagging is an excellent way to explore these variables
- But, US tagging was last done in the late 1970's and early 1980's

- **Herring distribution has changed in the last 2 decades with a shift to mobile gear and the recovery of Georges Bank**



from Overholtz et al. 2004



- **Anchor tagging began in 2003 and continued though 2004* targeting fish in the Gulf of Maine and Southern New England**

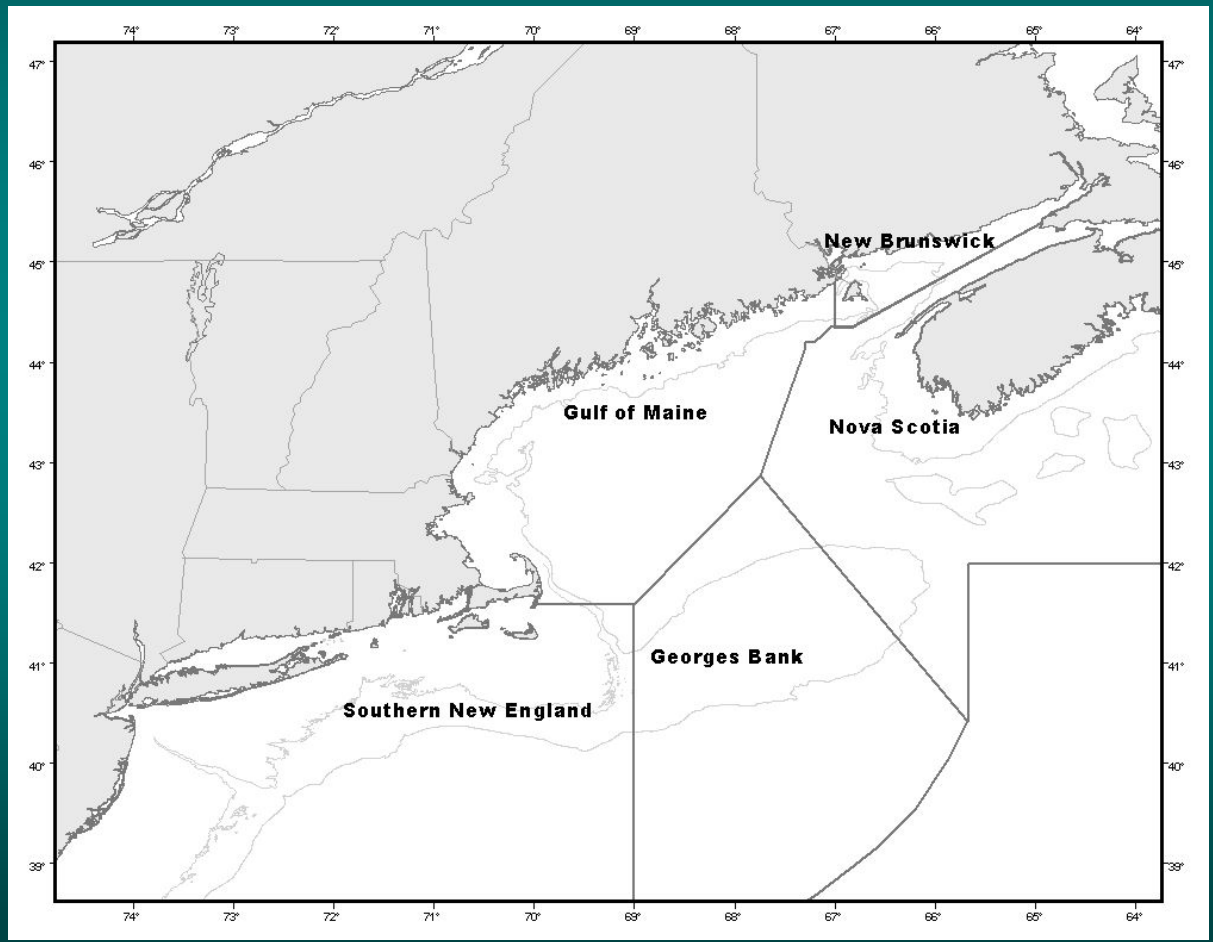
* Results presented are through 2004 but tagging will continue through 2006

Objectives of this project were:

- Implement an effective herring tagging project in the context of the recovered offshore stock and fishery
- Develop a means for adjusting tag returns based on catch and effort
- Use the adjusted returns to estimate proportional movement between stock and management areas

METHODS

- Spatial strata: GOM, SNE, GB, NS and NB



Temporal strata:

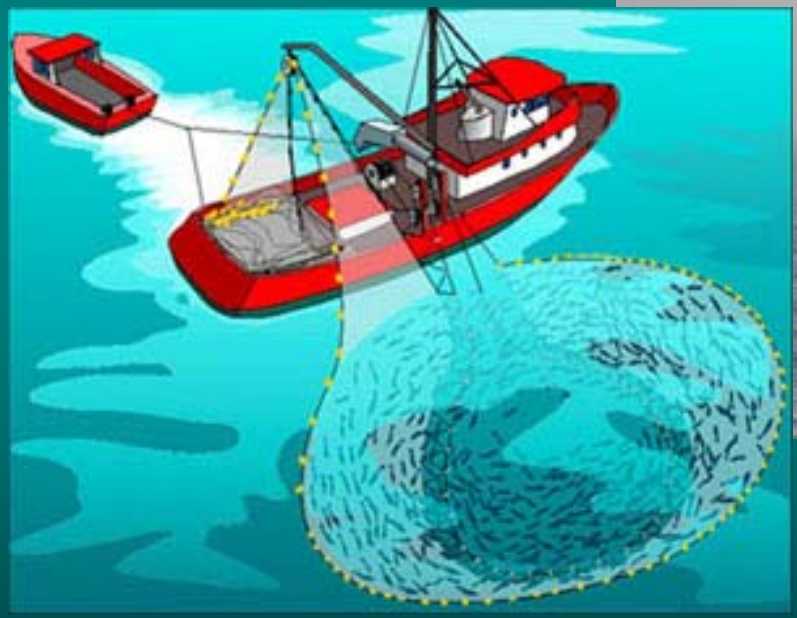
- Spring migration (May-June)
- Summer feeding/spawning (July-October)
- Fall migration (November-December)
- Winter feeding (January-April)

Marking techniques

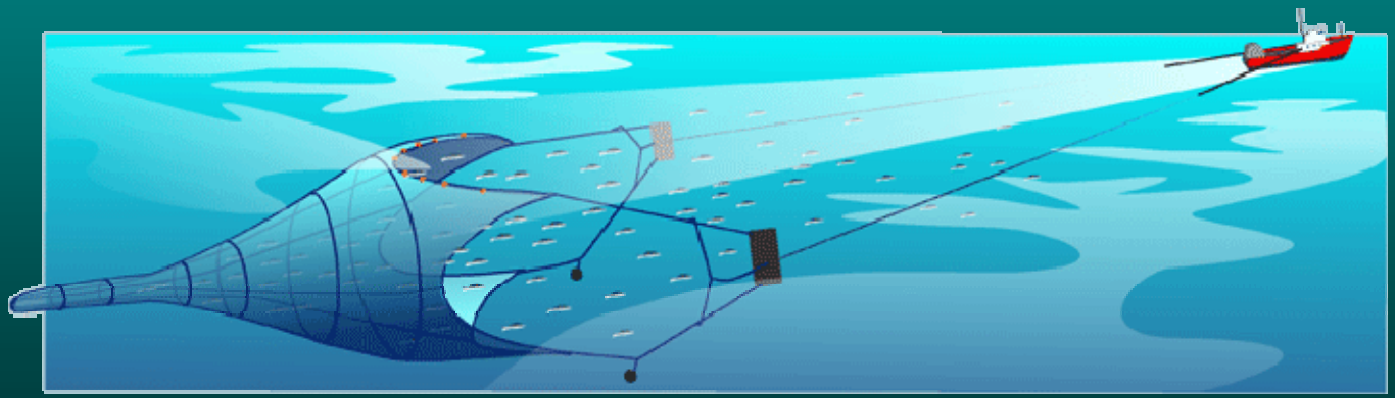
- Anchor Tags inserted below dorsal fin

Fieldwork

- Trips on purse seine vessels during commercial fishing operations



- **Trips on contracted midwater trawl vessels using an aquarium codend**



Outreach and return incentives

- Awareness: posters, articles, presentations, site visits and follow up with tag returns
- Lottery system: 1-$1,000 and 2-$500

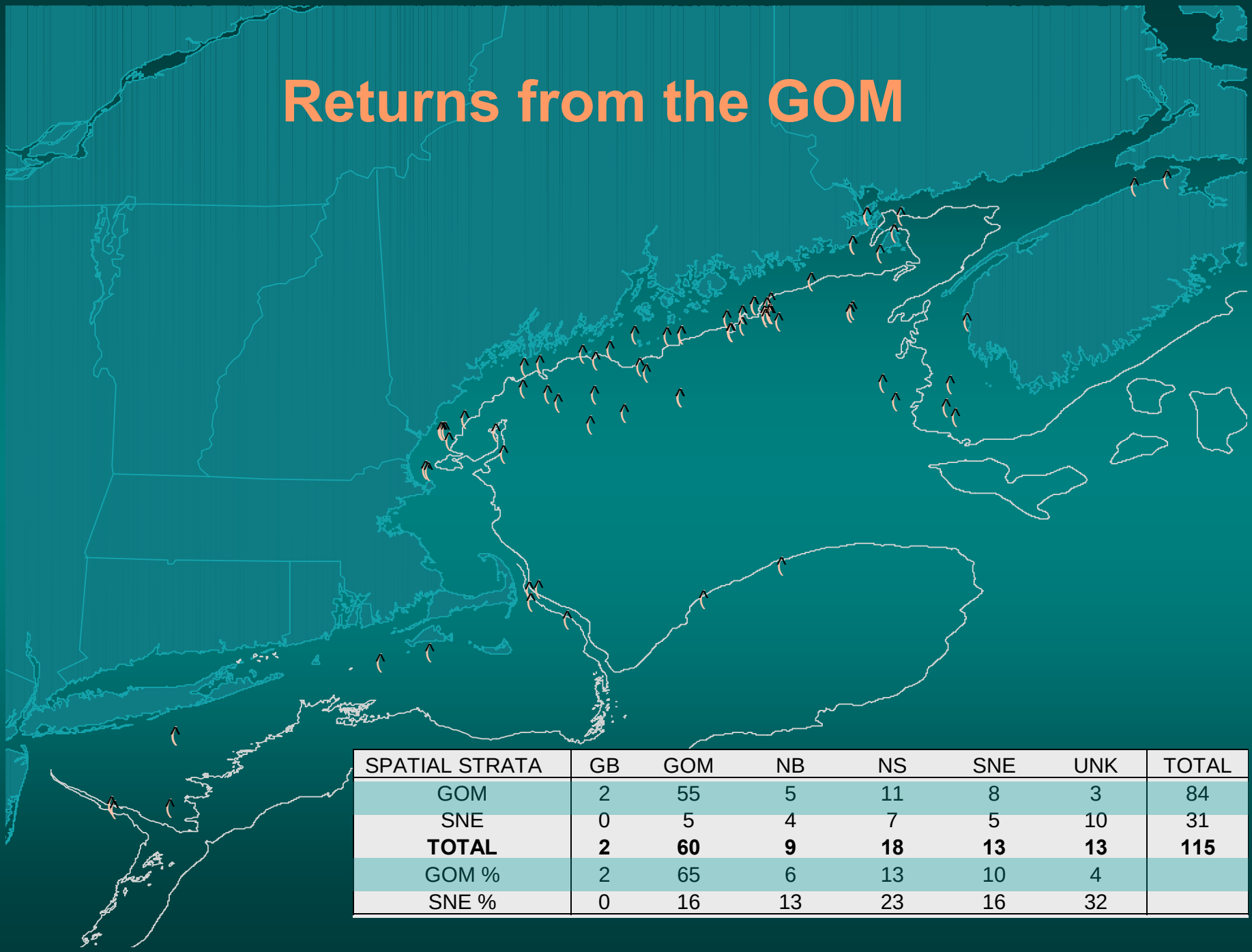
RESULTS

- 34 tagging trips in GOM and SNE
- 78 sets
- 39,161 fish tagged
- 115 tags returned
- Unadjusted return rate of 0.03%
- 87% of returns made after two weeks at large

Geographic distribution of returns

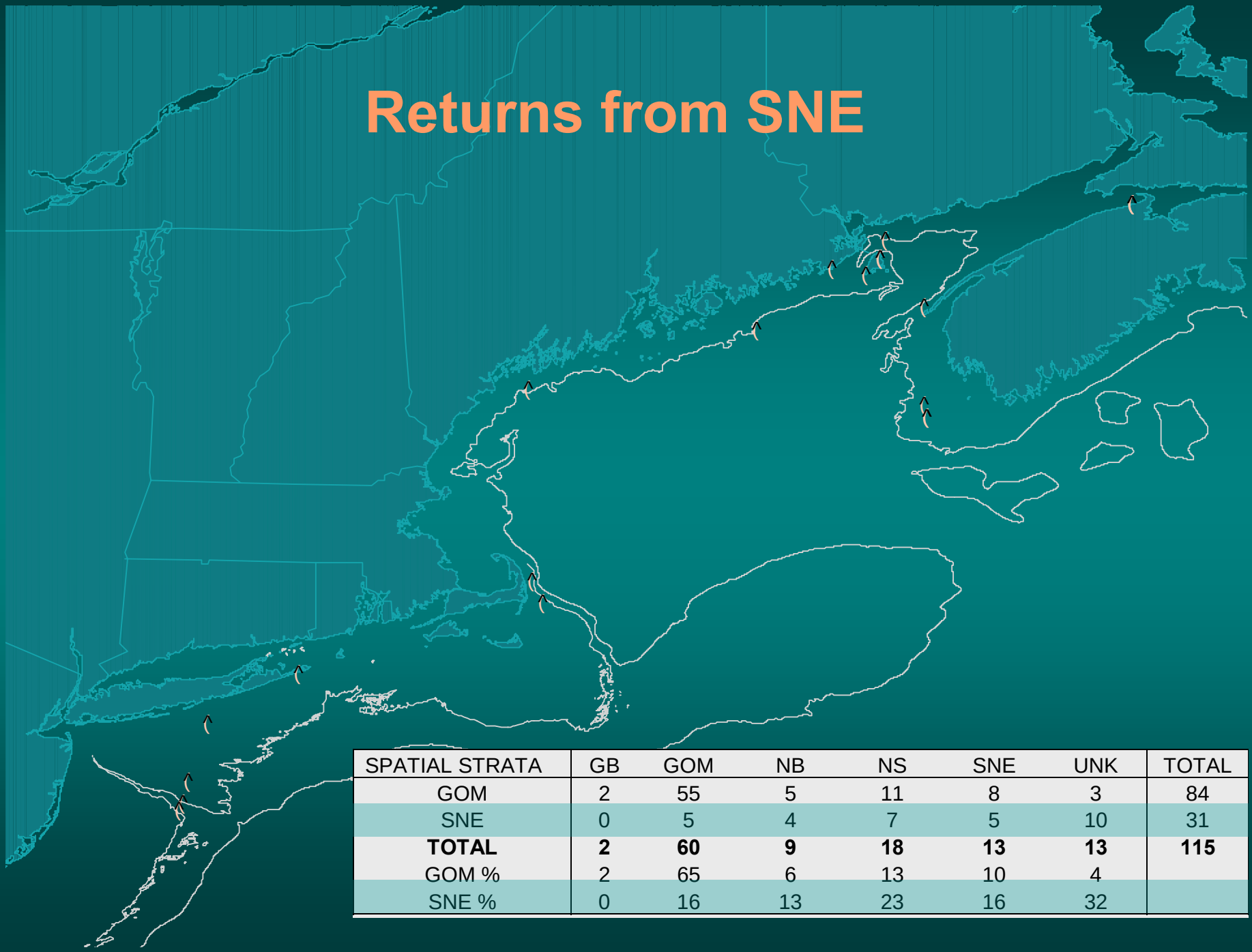
- GIS mapping of release locations and recovery locations for both years

Returns from the GOM



SPATIAL STRATA	GB	GOM	NB	NS	SNE	UNK	TOTAL
GOM	2	55	5	11	8	3	84
SNE	0	5	4	7	5	10	31
TOTAL	**2**	**60**	**9**	**18**	**13**	**13**	**115**
GOM %	2	65	6	13	10	4	
SNE %	0	16	13	23	16	32	

Returns from SNE



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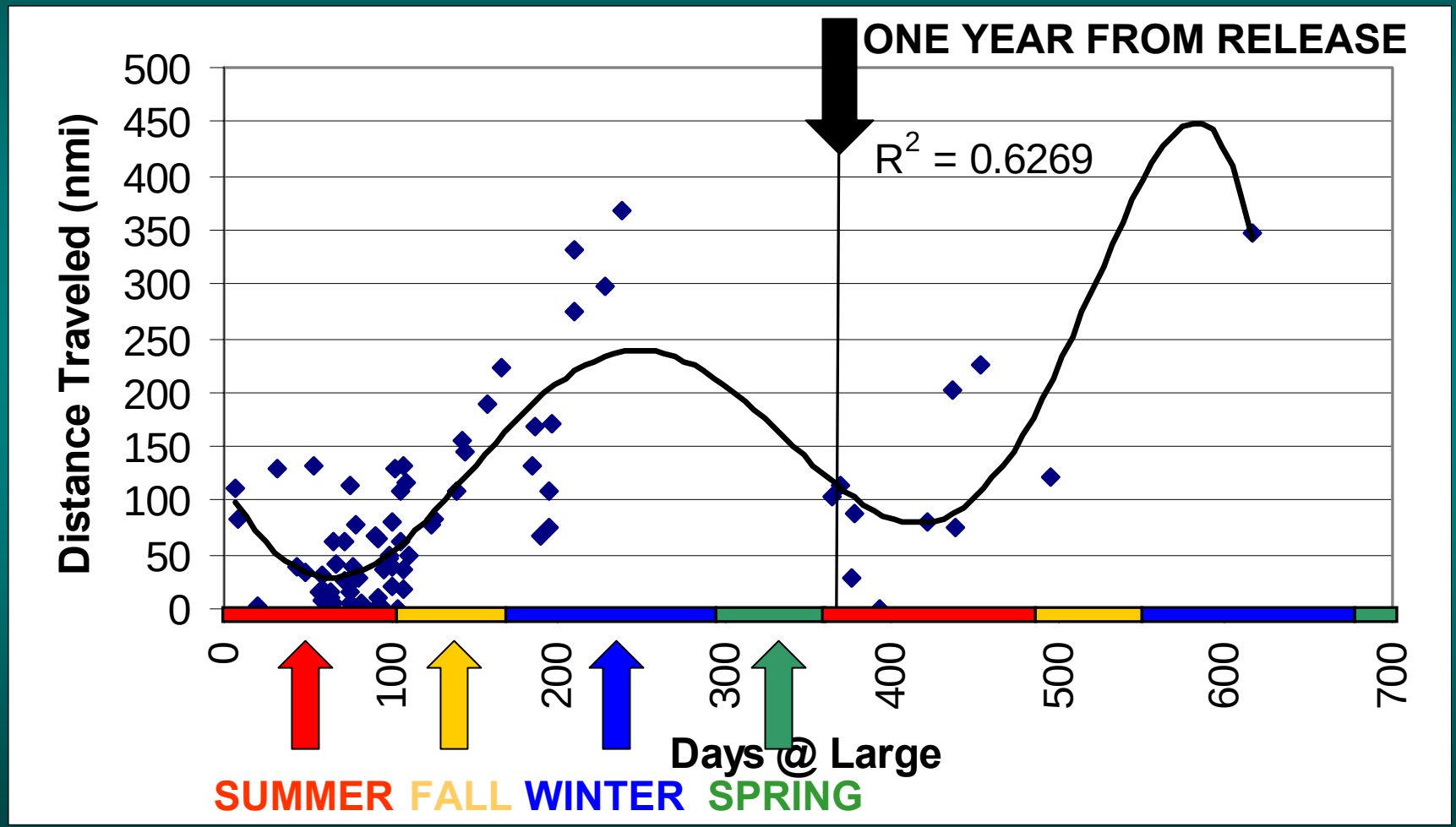
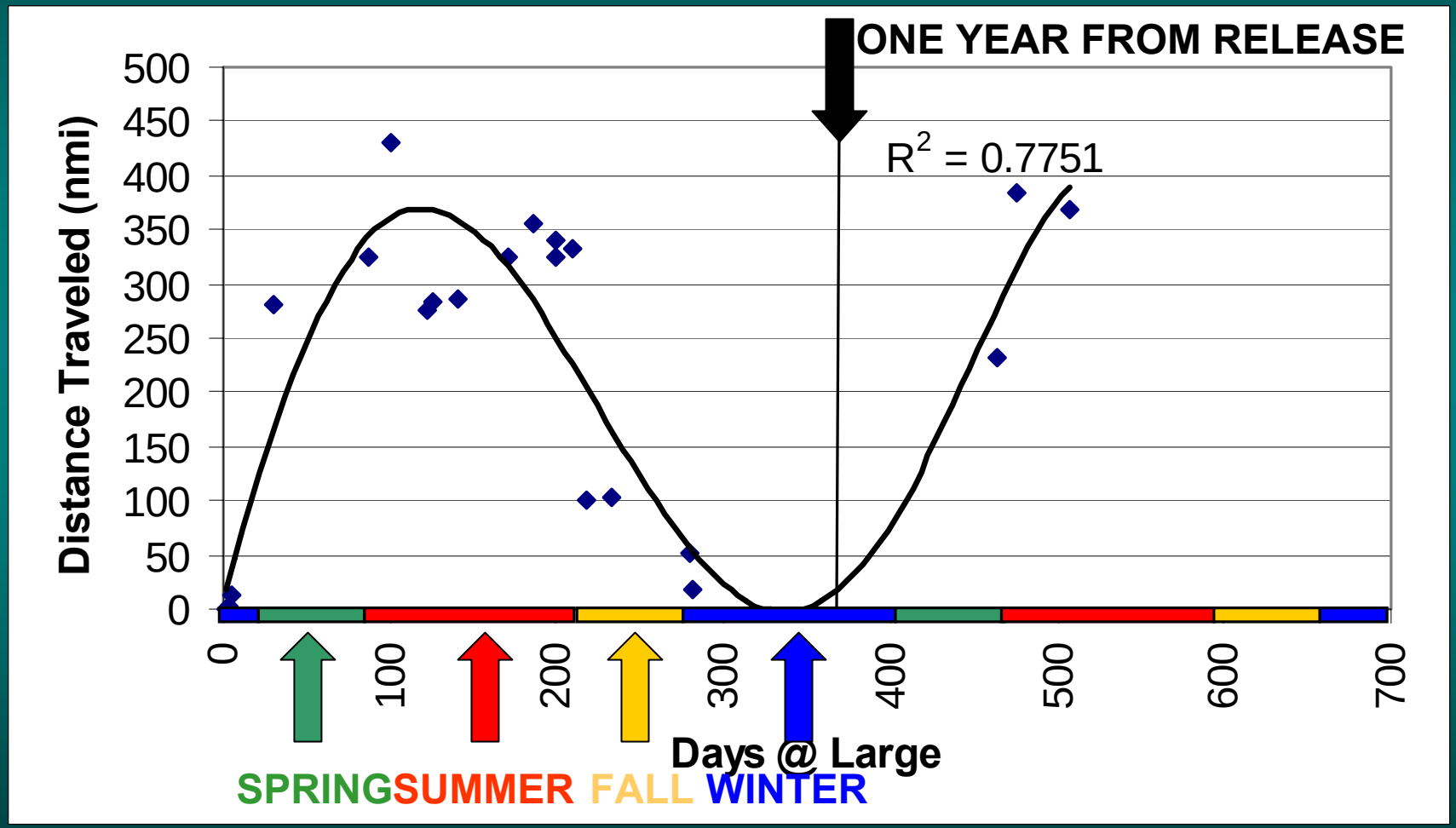
Seasonal movement

- Time-at-large / distance traveled plots
- Illustrate seasonal movement from winter feeding grounds to summer feeding/spawning areas and vice versa

Returns from fish released in the GOM



Returns from fish released in SNE



Tag return adjustments

- Adjusting return numbers for catch and effort by area and year
- Important for analyzing movement and potential stock intermixing

- **Adjustments based on Hunt et. al. 1999**

$$A_{a,y} = \sum C_{y}/(C_{a,y} \times E_{y}),$$

where A = adjustment factor;

C = percent of annual reported landings by management area;

E = reported annual exploitation rate by management area;

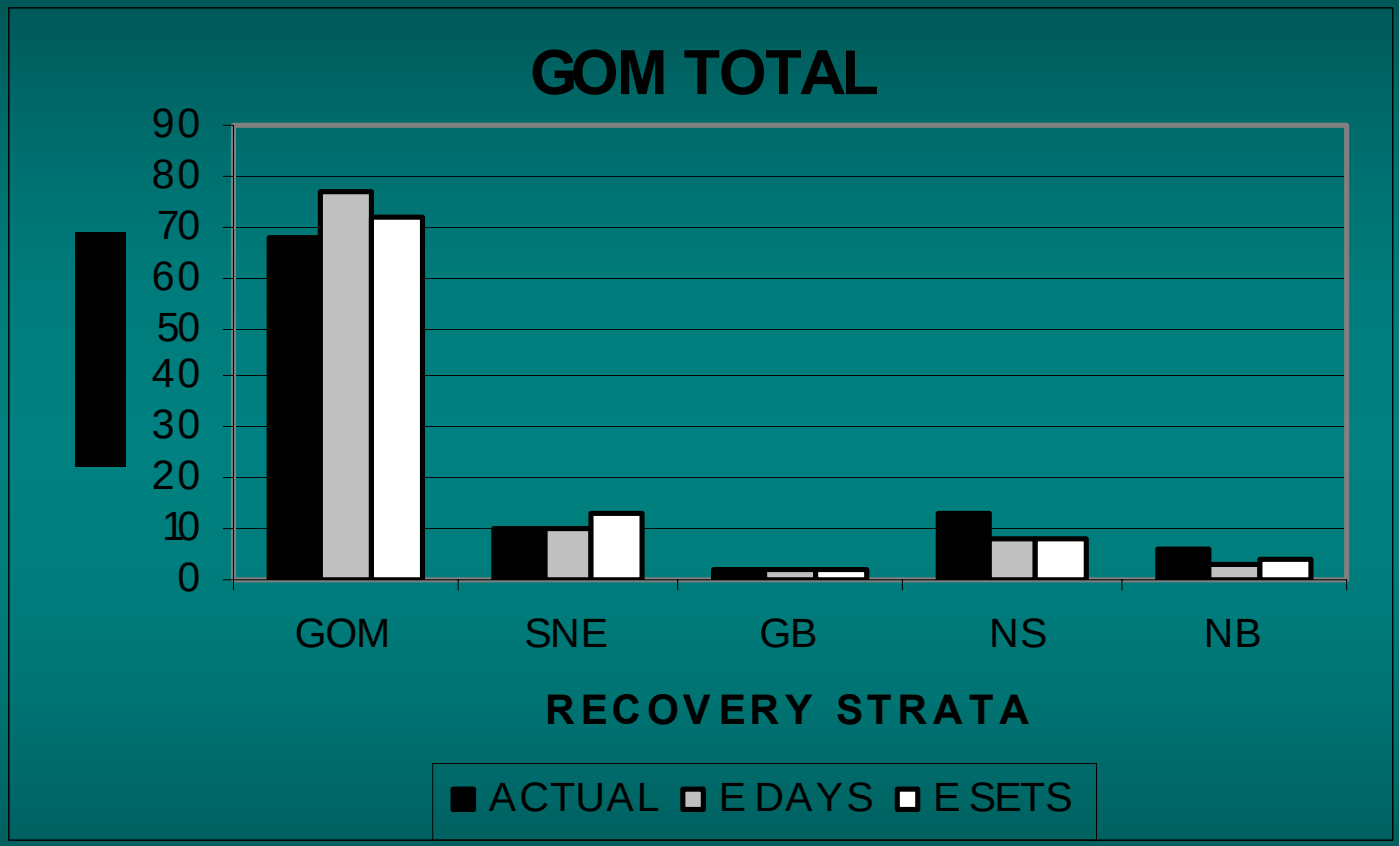
a = unit area; and

y = year.

- **Actual and adjusted tag returns from fish released in the GOM**

GOM Releases						
STRATA	ACTUAL TAGS	E/DAYS	E/SETS	% ACTUAL	% E/DAYS	%E/SETS
GOM	55	132	101	68	77	72
SNE	8	17	18	10	10	13
GB	2	3	3	2	2	2
NS	11	14	12	14	8	9
NB	5	6	6	6	3	4
TOTAL	81	172	140			

- **An easier way to look at the same data:**



- **Actual and adjusted tag returns from fish released in SNE**

SNE Releases						
STRATA	ACTUAL TAGS	E/DAYS	E/SETS	% ACTUAL	% E/DAYS	%E/SETS
GOM	5	29	22	24	57	51
SNE	5	8	8	24	16	19
GB	0	0	0	0	0	0
NS	7	9	8	33	18	19
NB	4	5	5	19	10	12
TOTAL	21	51	43			

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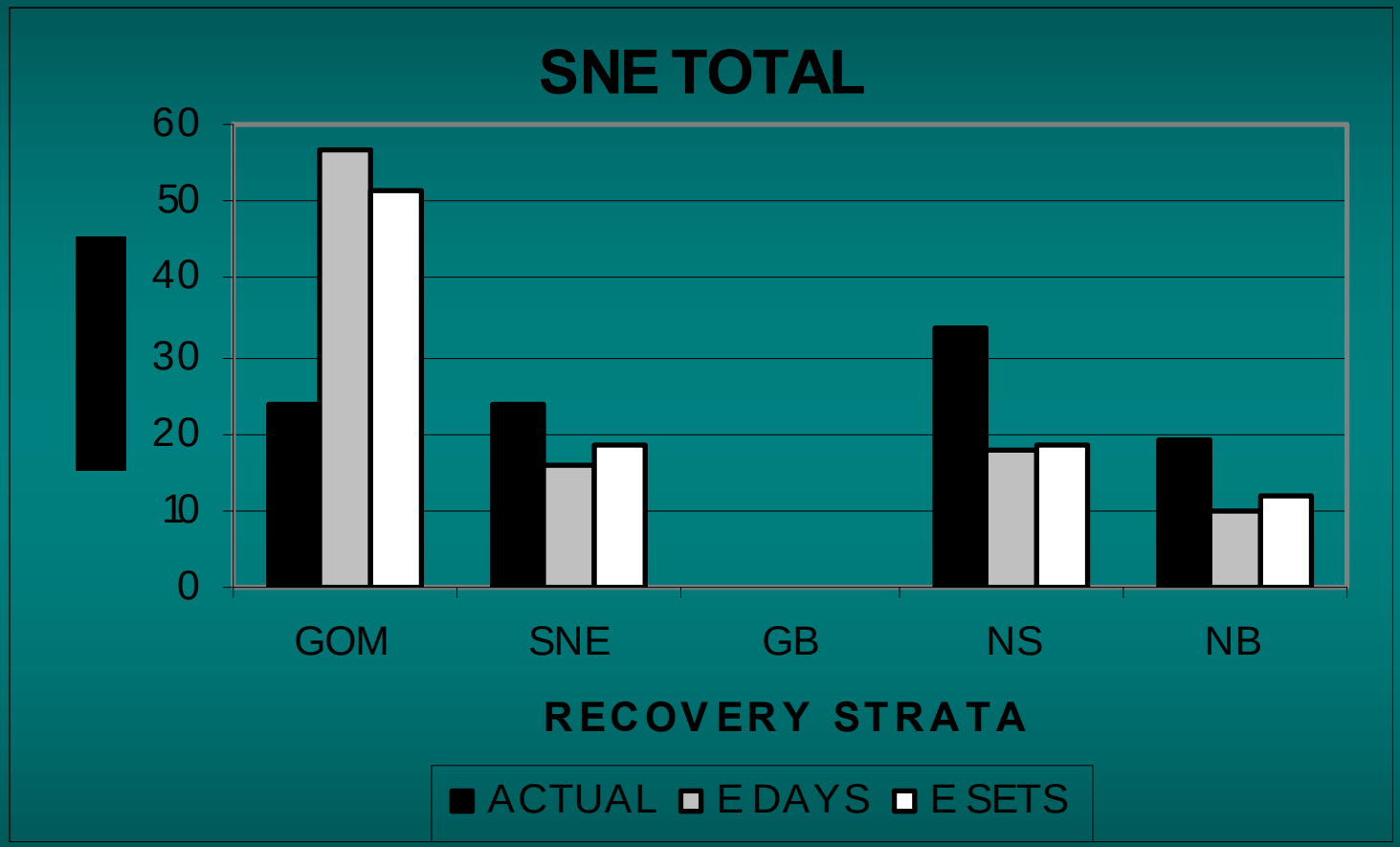
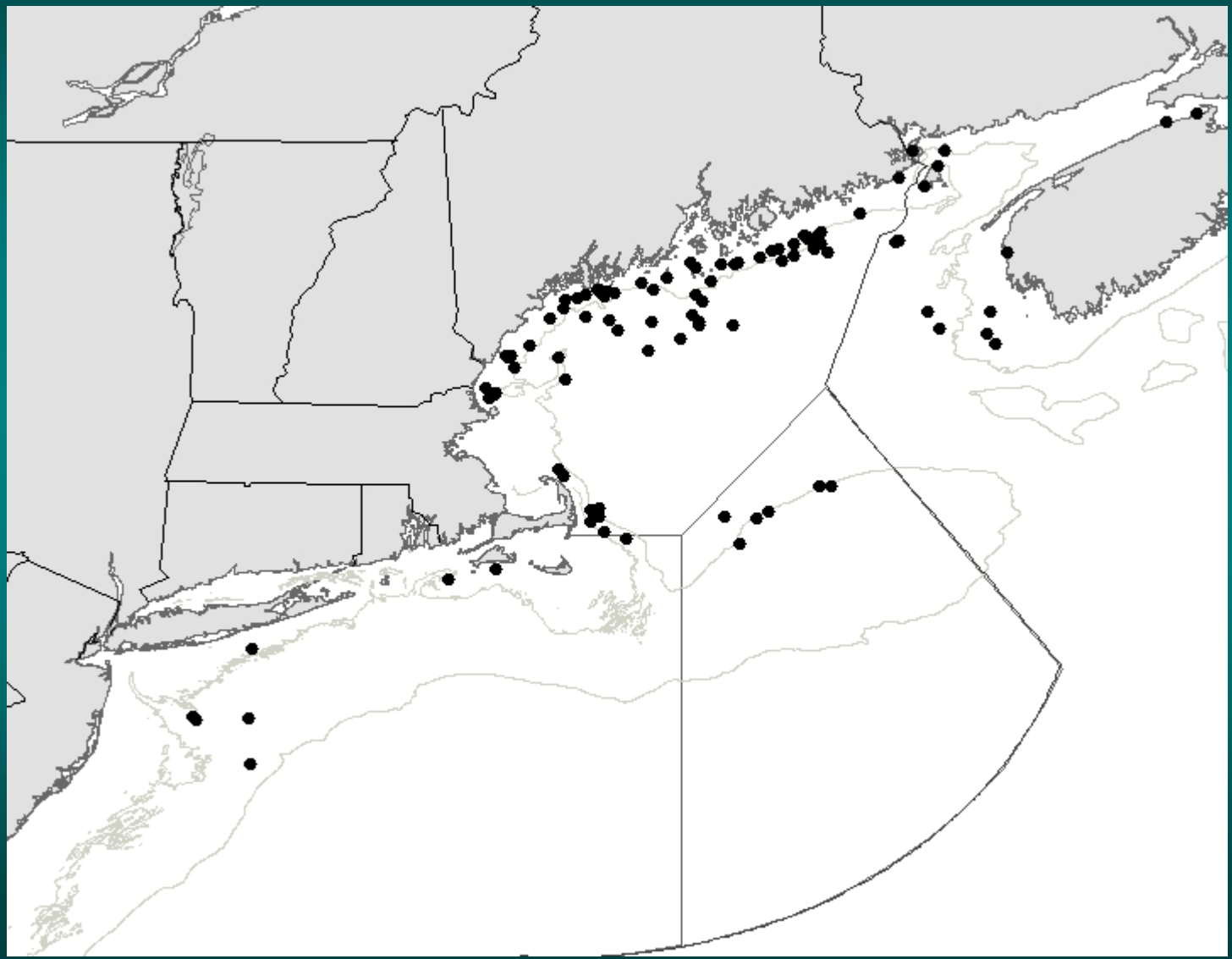


DISCUSSION

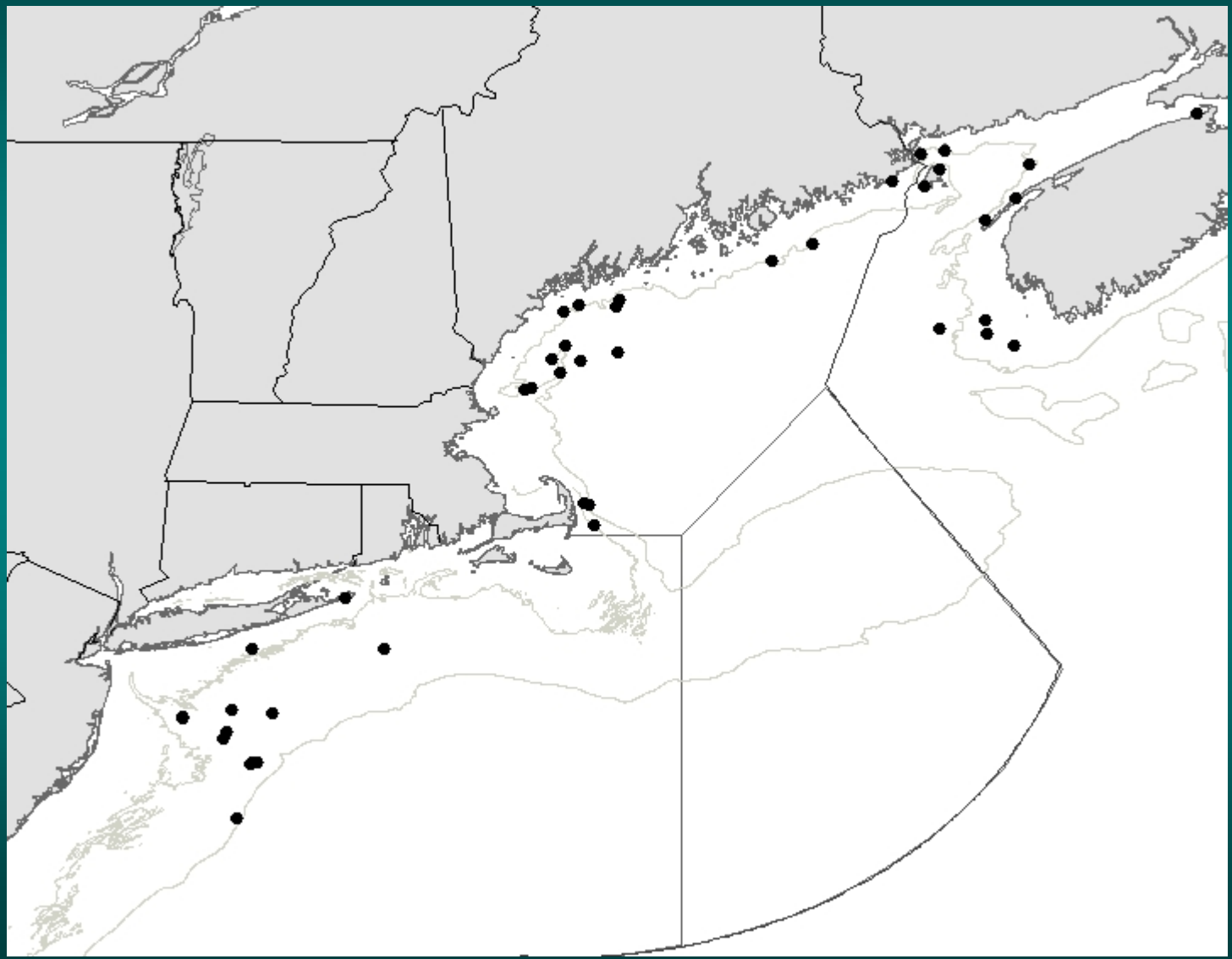
- Results from this study indicate that herring move between the five defined spatial strata
- There is apparently appreciable intermixing of herring stocks from the Gulf of Maine and Nova Scotia

- While the results are not entirely conclusive they call into question the current assumption that there is no appreciable intermixing between the US costal complex and the 4VWX stock

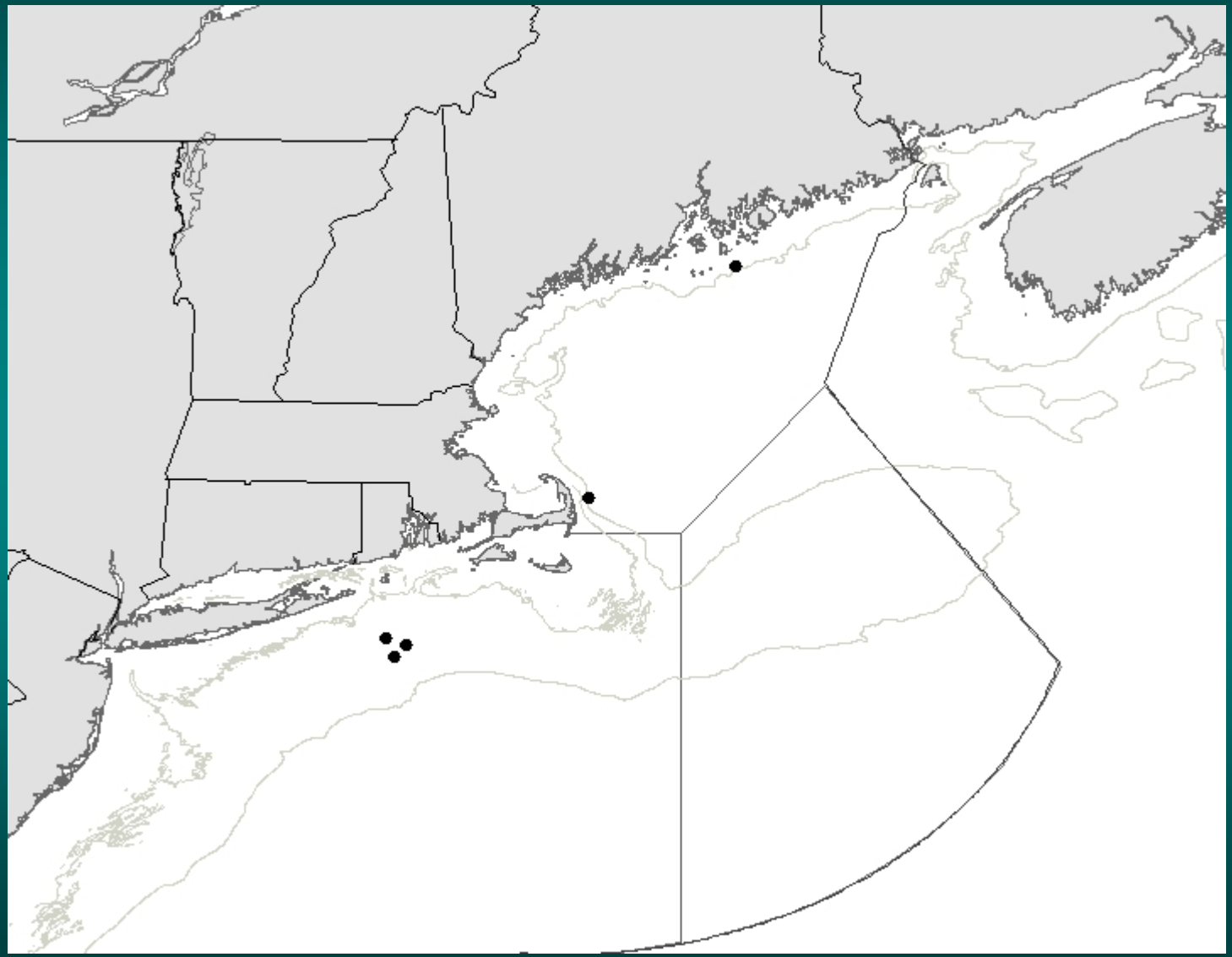
Returns from the GOM, 2005



Returns from SNE, 2005

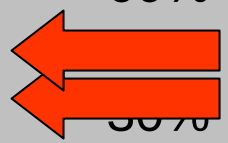


Returns from GB, 2005

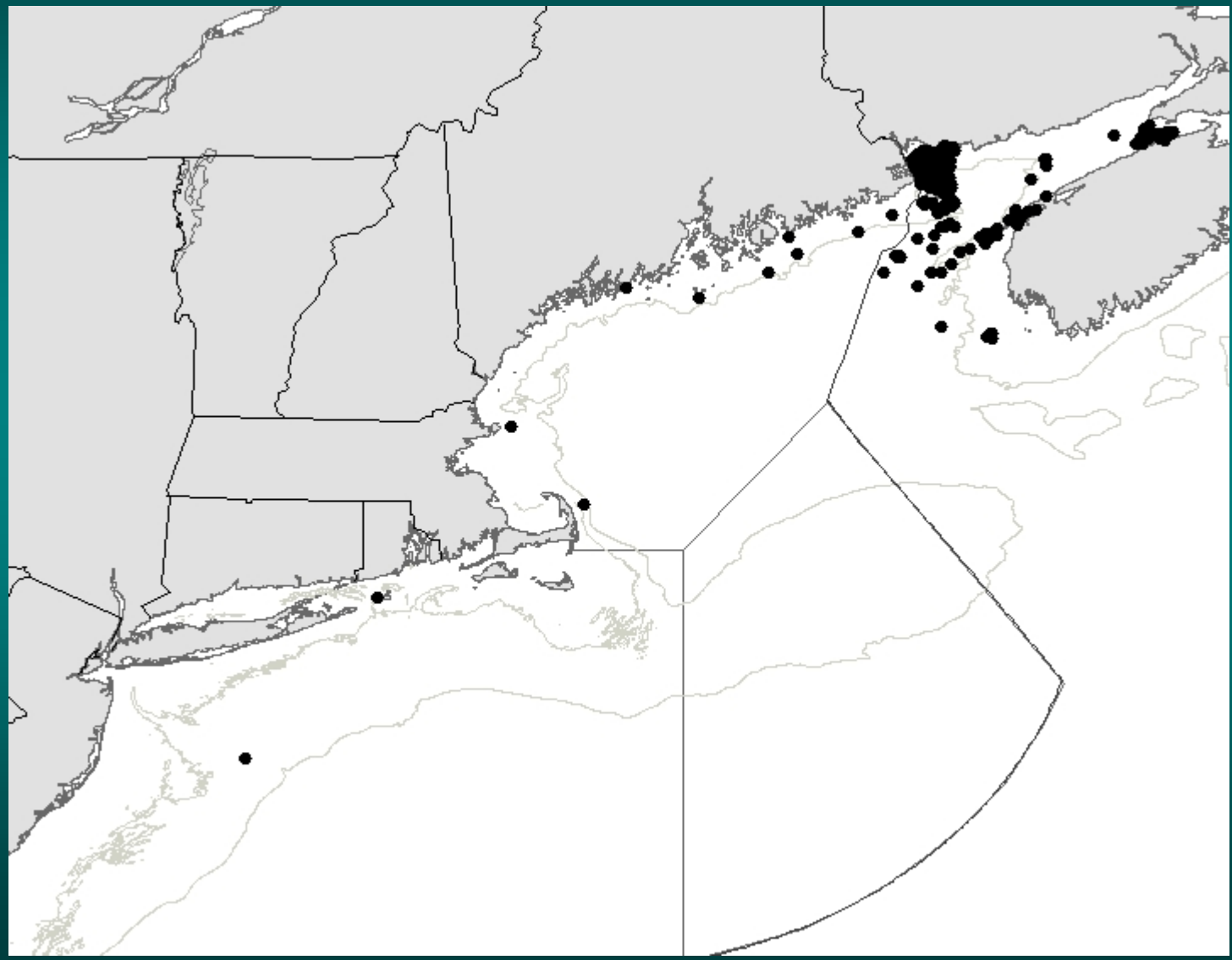


Unadjusted Returns from 2005

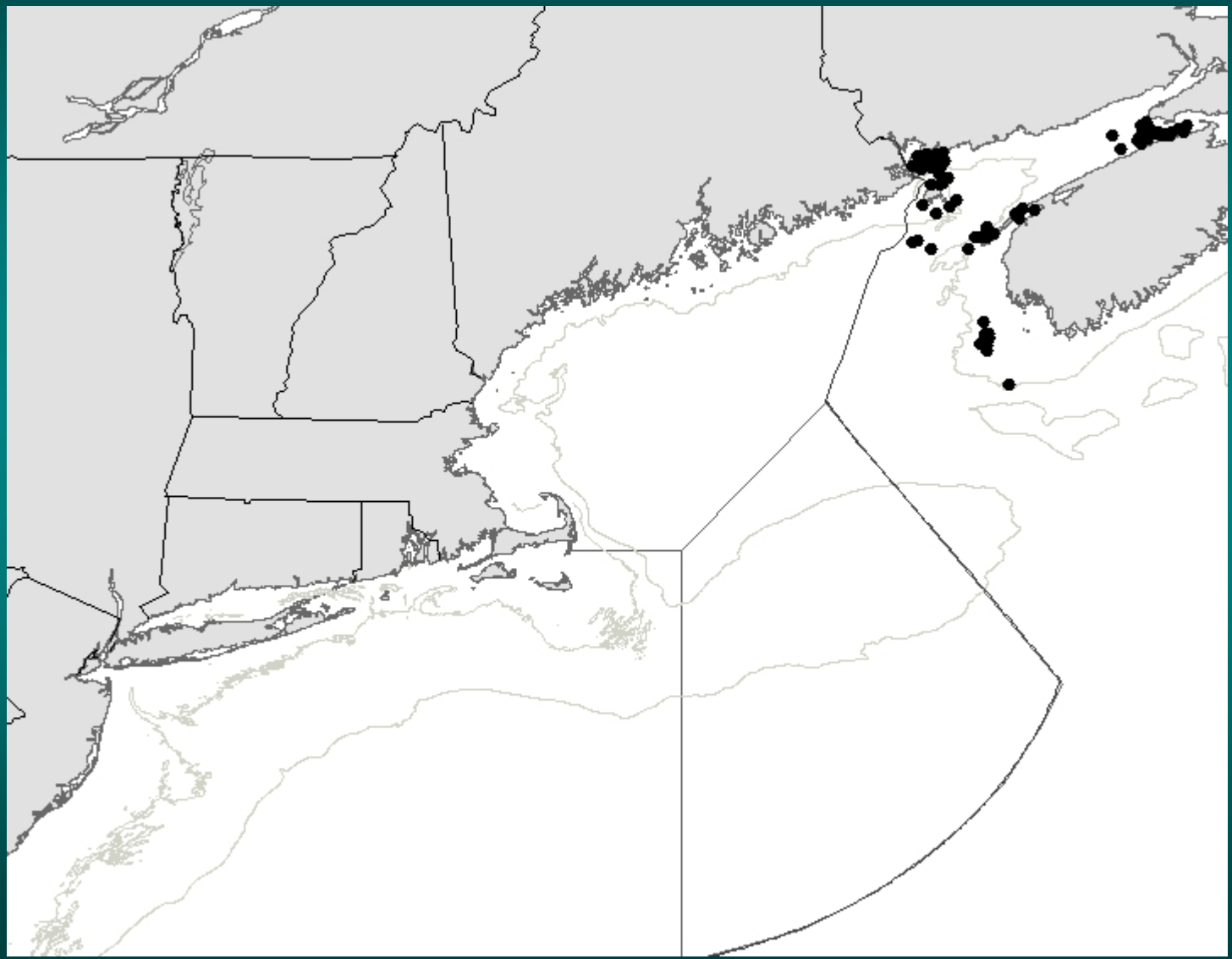
	GB	GOM	NB	NS	SNE	UNK	TOTAL
GB		2			3		5
GOM	6	92	5	13	9	4	129
SNE		22	8	16	25	13	84
UNK		2				1	3
TOTAL	6	118	13	29	37	18	221
GB	0%	40%	0%	0%	60%	0%	
GOM	5%	71%	4%	10%		3%	
SNE	0%	26%	10%	19%		15%	
UNK	0%	67%	0%	0%	0%	33%	



Returns from NB, 2002-2005



Returns from NS, 2005




Questions?